exponential theorem. I have demonstrated that in space $e^p \times e^q = e^{p+q}$, and the demonstration shows conclusively that the Hamiltonian ideas about the addition of vectors require to be revised. Although I have asked quaternionists to point out any error in the demonstration, no error has been pointed out.

The Hamiltonian principle that a unit-vector may be identified with a quadrantal versor requires to be modified. The conception of a line does not involve the idea of an angle, whereas the conception of an angle involves the idea of two lines. The question reduces to the following: Can a line be conceived apart from an initial line? The answer appears to be yes, for Hamilton did not succeed in his endeavors to extend algebra to space until he abandoned the idea of an initial line and considered all three axes as equally real. The vector and the versor are complementary ideas, and just as a vector is expressed in terms of rectangular coordinates which are in their nature vectors, so a versor is expressed in terms of rectangular quadrantal coordinates which are in their nature versors.

On the other hand, a vector cannot take the place of the versor. To ignore the versor and more generally the quaternion is the mistake made by writers who confine space-analysis to vector-analysis, which is merely a branch. The very name vector-analysis implies a restricted view of space-analysis. The versor is the proper idea in spherical trigonometrical analysis, and in a modified form expresses the rotation of a rigid body. It leads up to higher ideas which express elliptic and hyperbolic angles and the motion of a body which is not rigid.

In mathematical analysis the product of two quantities having the same direction is positive, while that of two quantities having opposite directions is negative; consequently the square of a quantity is always positive. Consistent with this the reciprocal of a negative quantity is the negative of the reciprocal. Now, are all the quantities considered in algebra or the Cartesian analysis scalar quantities, or are they in some cases partial vectors? If in any case they are partial vectors (that is, component of a vector) then, in order to be consistent, the square of a vector in space must be positive and the reciprocal of a vector have the same direction as the vector.

The order of writing of the terms of a sum or the factors of a product should conform, as far as possible, to the order followed in mathematical analysis. There the natural order of writing is followed, from left to right, and, as in a determinant, from top to bottom. But in books on Quaternions, for example, Hathaway's Primer, p. 49, we have the Hebrew order of writing. This abnormal order of writing was adopted from the idea that a product of quaternions supposed an operand and that the operand ought to be on the right. As a matter of fact, in the expression for the rotation of a versor the operator is written both before and behind.

ALEXANDER MACFARLANE.

## SCIENTIFIC JOURNALS.

### JOURNAL OF GEOLOGY, APRIL–MAY.

PROFESSOR CHAMBERLIN continues his glacial studies in Greenland, giving a description of the Bowdoin glacier. This is a tongue of the great inland ice-cap which descends from the north into the head of Bowdoin Bay. On the west it is confluent with the Tuktoo and Sun glaciers. The Bowdoin glacier has a length of six or eight, and in its lower part a breadth of about two miles. It has a descent of 2,000 to 3,000 feet, and is notably crevassed. It discharges icebergs of considerable dimensions, the discharge varying greatly with the season. The west side does not present the usual vertical scarp, and this is thought to be due to the fact that the ground which should act as a reflecting plane is covered by protuberances from the Tuktoo glacier. The stratification and basal loading of the ice is much the same as in the glaciers previously described, though the débris does not rise so high. The bowlders were usually more rounded, and this rounding is of such a nature as to imply very considerable wear. This considerable rounding, the small amount of débris and its low position in the ice are especially significant in view of the fact that the Bowdoin is one of the larger tongues of the great icecap.

Dr. Henry Washington describes the Rocca Monfino region in the fourth of his Italian

Petrological Sketches. The rocks of the region belong to three periods of activity: (1) the leucitic characterized by leucites and leucite-tephrites, (2) the trachytic and (3) the basaltic. Among the rocks of the first period is a biotite-vulsinite, a rock intermediate between the trachytes and andesites. The silica is lower than in the vulsinites, the lime, iron and magnesia very much higher and the alkalies considerably lower. Chemically the rock is almost identical with ciminite, but in deference to the present mineralogical classification of rocks it is put with the vulsinites.

Are the Bowlder Clays of the Great Plains marine? is asked by Dr. George M. Dawson, and as a reason for the question he enumerates several species of foraminifera, in part modern forms, determined from the Canadian bowlder clays by Mr. Joseph Wright.

The Beauxite deposits of Arkansas are described by Professor John C. Branner. The beauxite deposits were discovered by the recent Geological Survey of that State and are of ferruginous, earthy and kaolin-like varieties with pisolitic structure. In age they probably belong to the Tertiary. They appear to have been laid down in water near the shore and, in part at least, to have been uncovered at low tide or broken up by storm waves, rolled, and finally left at or near where the material had originally lain. In the opinion of Professor Branner, before the eruptive syenites had cooled they were sunk beneath the Tertiary sea, and either by the contact of the sea water or the issuing of springs, whose waters had been in contact with the hot syenites, the aluminous materials were segregated as pisolite and sank near where they were formed. The beds have not been developed, though they could be used to advantage as a refractory material in the manufacture of iron and steel. The paper includes a considerable bibliography.

H. F. B.

## *SOCIETIES AND ACADEMIES.*

### NEW YORK ACADEMY OF SCIENCES—SECTION OF GEOLOGY, APRIL 19, 1897.

The evening of the monthly meeting of the Section was devoted to a reception, by the whole Academy, to Sir Archibald Geikie, Director-General of H. M. Geological Survey of Great Britain, who had just returned to this country for a brief visit after an absence of eighteen years. After an informal reception the meeting was called to order and addressed briefly by the President of the Academy, Professor J. J. Stevenson, who extended a most hearty welcome from the scientists of New York to the guest of the evening. Professor Stevenson was followed by Professor J. F. Kemp, the Chairman of the Section, who reviewed in a few words the greater contributions of Sir Archibald Geikie to the cause of geology. He spoke of his early work in Scotland, in France and in the western United States in the study of vulcanism, and paid particular attention to the work that had been done in Scotland on the metamorphic rocks. Professor Kemp concluded with a tribute to Sir Archibald as a naturalist, and spoke of the superior quality of work that is given the world by the man who is in love with nature and finds in the solitude of the wildness of nature his greatest company and inspiration.

The next speaker was the Secretary of the Section, who spoke particularly of the work of Sir Archibald Geikie as looked at from the standpoint of the teacher and physiographer. He reviewed hastily the character and quality of Geikie's Text-book and Class-book of Geology, and spoke more especially of the example this distinguished geologist has set in physiography in the masterly analysis of the physical features of Scotland given in his Scenery of Scotland.

The last address of welcome was given by Professor Angelo Heilprin, of Philadelphia, who spoke as a traveler and contrasted the knowledge of the geology of the world now with our knowledge at the time of Humboldt. He spoke of how much we owed to the guest we were welcoming for his work in bringing together the shreds of knowledge from all parts of the world and in building up a great mass of geological information, which is a vast help to all workers in geology and a stimulus to all.

In reply Sir Archibald Geikie expressed his thanks to the Academy for the very cordial reception that had been tendered him in New York. He contrasted the appearance of the